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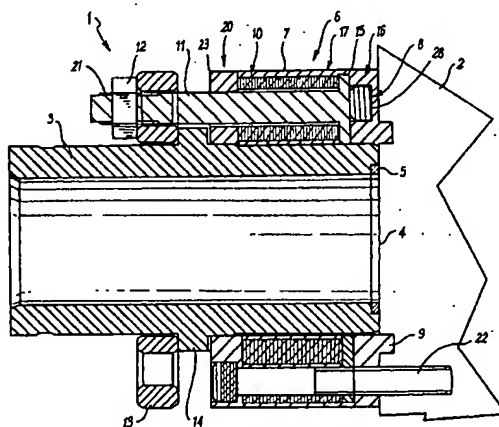
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(54) Title: LINER RETENTION SYSTEM



(57) Abstract: Apparatus and method for securing a cylinder liner to a pumping module. A first part of an assembly housing pistons is fastened to a pumping module and a second part of the assembly is brought against the first so that the pistons act on tensioning plates which each have a stud rod extending therefrom through the assembly at an end distal to the pumping module. Each rod has a first portion substantially surrounded in an elastomeric member and a second portion threaded to receive a nut. The rods are passed through a clamping ring on the cylinder liner and the nut is attached to the rod. Actuating the pistons causes initial compression of the elastomeric member by the tension plate and allows tightening of the nut toward the pumping module. Release of the pistons then causes expansion of the elastomeric member to forcibly compel the cylinder liner towards the pumping module.

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1    Liner Retention System

2

3    This present invention relates to apparatus for aligning  
4    and securing cylinder liners to pumps and in particular,  
5    though not exclusively, to apparatus for aligning and  
6    securing cylinder liners of reciprocating pumps to their  
7    respective pumping modules.

8

9    In the past, there have been several different types of  
10    ways to attach cylinder liners to their respective  
11    pumping modules and these may vary according to make of  
12    pump in which they are used. One embodiment presently  
13    known employs a tapered concentric clamp, while another  
14    uses a concentric screw clamping arrangement.

15

16    It is important that the means for aligning and securing  
17    the cylinder liners may be implemented without undue  
18    effort and down-time. Cylinder liners are required to be  
19    changed frequently and this causes considerable  
20    inconvenience if the means and method for releasing the  
21    old cylinder liners and fitting the replacement cylinder  
22    liners are slow or difficult to operate. It has been  
23    found that original pump manufacturers' systems or means

1 for securing cylinder liners to respective pumping  
2 modules have been difficult to operate for a plurality of  
3 reasons, including the involvement of heavy components,  
4 the handling of which may be dangerous for operators.  
5 These systems also require considerable strength, skill  
6 and reliability of operators, together with the use of  
7 heavy tools in confined spaces. Yet further, the securing  
8 force is dependent on the extent of wear and the general  
9 condition of a plurality of the securing components.

10

11 US RE37,483 has overcome some of these problems in  
12 providing an apparatus for securing a cylinder liner to a  
13 pumping module in a reciprocating pump which has a set of  
14 arrangements each with a hydraulically activated piston,  
15 a rod attached to the piston which is adapted to receive  
16 a nut, the retraction of which forcibly compels in  
17 attraction against a spring, the cylinder liner and the  
18 pumping module. In particular, this apparatus provides a  
19 tool which can be operated by hand. A further advantage  
20 is that the tool uses components which are considerably  
21 lighter than those of the prior art to ease handling.

22

23 However, excepting the nuts and clamping ring, the  
24 assembly of the apparatus must be completed prior to  
25 lifting and positioning on the pumping module. Thus  
26 although the individual components may be comparatively  
27 lighter, the combined weight of the assembled apparatus  
28 makes it difficult to handle. A further disadvantage of  
29 this apparatus is that the metal springs used may be  
30 prone to failure if the pump is instantaneously run at  
31 full speed. This is because a hydraulic shock is set-up  
32 through the pump which causes the springs to flatten and  
33 fracture by banging.

1  
2 It is an object of at least one embodiment of the present  
3 invention to provide a liner retention tool which  
4 mitigates at least some of the problems of the prior art.  
5

6 According to a first aspect of the present invention,  
7 there is provided an apparatus for securing a cylinder  
8 liner to a pumping module, the apparatus comprising one  
9 or more arrangements each fastened to said pumping  
10 module, each arrangement comprising an assembly including  
11 a piston, the piston acting on a tension plate, the  
12 tension plate having a stud rod extending therefrom out  
13 from the assembly at an end distal to the pumping module  
14 and thereon passing through a respective aperture in a  
15 clamping member adapted to grip the cylinder liner, the  
16 rod having a first portion substantially surrounded in an  
17 elastomeric member and a second portion threaded to  
18 receive a nut, wherein initial compression of the  
19 elastomeric member by the tension plate and tightening of  
20 the nut toward the pumping module, followed by release of  
21 the elastomeric member forcibly compel the cylinder liner  
22 towards the pumping module.

23  
24 Preferably the elastomeric member comprises a multi-layer  
25 structure having layers of flexible material interleaved  
26 with layers of strengthening material. The flexible  
27 material may be a rubber or the like. The strengthening  
28 material may be a metal, composite or other known  
29 material having a relatively high Young's modulus. In one  
30 embodiment the strengthening material may be a fabric  
31 reinforcement arranged through the elastomer.  
32

1 Use of an elastomer prevents failure by hydraulic shock  
2 if the pump is started at full speed.

3

4 Preferably the assembly comprises at least two parts, a  
5 first part including the piston and a second part  
6 including the tensioning plate, rod and elastomeric  
7 member wherein the parts are separable for assembly and  
8 disassembly. Preferably the first part is located in a  
9 housing. The second part may also be located in a  
10 housing.

11

12 This separation of the parts provides for easier assembly  
13 over the prior art.

14

15 Preferably the/each piston is a hydraulic piston. More  
16 preferably the piston and a base of the housing define a  
17 space for accommodating hydraulic fluid.

18

19 Preferably also there are four arrangements arranged  
20 equidistantly around and externally of a circumference of  
21 the cylinder liner. Alternatively there are six  
22 arrangements arranged equidistantly around and externally  
23 of a circumference of the cylinder liner.

24

25 Preferably the clamping member comprises a clamping ring  
26 including the apertures for receiving the stud rods.

27

28 According to a second aspect of the present invention  
29 there is provided a method of securing a cylinder liner  
30 to a pumping module of a pump, the method comprising the  
31 steps:

32

- 1 (a) locating a first part of an assembly including a
- 2 piston onto the pumping module;
- 3 (b) locating a second part of an assembly including an
- 4 elastomeric unit and a stud bolt having a tension
- 5 plate attached thereto, onto the first part;
- 6 (c) locating the cylinder liner against a seal on the
- 7 pumping module;
- 8 (d) placing a clamping ring over the cylinder liner;
- 9 (e) inserting the stud bolt through an aperture in the
- 10 clamping ring;
- 11 (f) placing a nut on a threaded portion of the stud bolt
- 12 and locating the nut against the clamping ring;
- 13 (g) actuating the piston against the tension plate to
- 14 compress the elastomeric member and force the stud
- 15 bolt through the aperture;
- 16 (h) at full compression, tightening the nut against
- 17 the clamping ring; and
- 18 (i) releasing the piston and by the expansion of the
- 19 elastomeric member thereby sealing the cylinder
- 20 liner to the pumping module.

21

22 The method may include the step of pumping hydraulic  
23 fluid to the piston to actuate the piston.

24

25 An example embodiment of the invention will now be  
26 described by way example only, with reference to the  
27 accompanying Figures, in which:

28

29 FIG. 1 is a cross-sectional view of an apparatus  
30 according to the present invention mounted on a pumping  
31 module with a cylinder liner.

32

33 A reciprocating pump generally described at 1 comprises a

1 module 2 and cylinder liner 3. It is desirable that the  
2 cylinder liner 3 is securely held up against the face 4  
3 of the module 2. Between the cylinder liner 3 and the  
4 module 2 there is provided a seal 5 which, in its  
5 unenergized (i.e., uncompressed) state, must be  
6 compressed by the cylinder liner 3 to close a gap created  
7 between the adjacent faces of the module 2 and cylinder  
8 liner 3.

9  
10 In order to prevent the existence of this gap, it is  
11 necessary to forcibly push the cylinder liner 3 against  
12 the module 2 and this is achieved by securing means,  
13 generally described at 6. The effect of compressing the  
14 cylinder liner 3 against the face 4 of the module 2 is to  
15 energise or compress the seal 5. This compression is of  
16 course desirable to increase the effectiveness and  
17 efficiency of the seal 5. The securing means 6 comprises  
18 one or more arrangements 20. Each arrangement includes an  
19 assembly comprising three parts abutted together; a first  
20 part 16, integral with a baseplate 9, located against the  
21 pumping module 2; a second part 17, the central portion,  
22 located against the first part; and a third part 20  
23 located at an end distal to the pumping module 2 and  
24 abutted to the second part 17. The assemblies are  
25 enclosed in housings, generally indicated at 7.

26  
27 The first part 16 houses a piston 8 which is  
28 hydraulically operated by the insertion of hydraulic  
29 fluid into a space 23 between the base of the piston and  
30 the rear face of the housing. In this way piston 8 may  
31 travel into the second part 17. The first part 16 is  
32 integral with the baseplate 9. The second part 17 is a  
33 cylindrical body into which is located an elastomeric

1 member 10 and a stud bolt 11. The elastomeric member 10  
2 has a cylindrical body and a bore passing therethrough.  
3 The elastomeric member 10 is made up of layers of a  
4 flexible material e.g. rubber and a strengthening  
5 material e.g. metal or fabric arranged perpendicular to  
6 the bore. The rod 11 has a tension plate 15 attached to  
7 one end and has a threaded portion 21 on the opposing  
8 end. The rod 11 is located through the bore of the  
9 elastomeric member 10 and extends from the housing away  
10 from the pumping module 2. Tension plate 15 has a  
11 circular face arranged to abut the piston 8 and an  
12 annular face arranged to abut a bottom face of the  
13 elastomeric member 10. The third part 23 of the housing 7  
14 is a top cover plate having an aperture through which the  
15 rod 11 passes.

16

17 On exiting the housing 7 the rod passes over a lug 14  
18 located on the cylinder 3 and through an aperture in a  
19 clamping ring 13 arranged around the cylinder. The  
20 threaded portion 21 of the rod 11 extends beyond the  
21 clamping ring 13 and a nut 12 is placed thereon.

22

23 In an alternative embodiment the housing 7 covers only  
24 the first part and the second and third parts are  
25 exposed.

26

27 In the embodiment shown, the securing means 6 includes  
28 one or more of arrangements 20 having the aforementioned  
29 components 7,8,10,11,12 and 15. The arrangement is  
30 permanently bolted by bolts 22 to the module 2, although  
31 the nuts 12 are detachable, thereby allowing removal of  
32 the cylinder liner 3.

33



1 Advantageously in assembling the securing means 6 to the  
2 pumping module 2, the baseplate 9 with the first part 16  
3 of the housing can be separated from the remaining  
4 components of the housing. The remaining components can  
5 all be assembled individually. This reduces the need to  
6 manhandle heavy pre-assembled parts onto the pumping  
7 module 2.

8  
9 In use, when a cylinder liner 3 is positioned against or  
10 nearly against the module 2, the shoulder or clamping  
11 ring 13 is then fitted over each of the stud rods 11. The  
12 nuts 12 are then threadably applied to the rods 11. The  
13 method of forcibly securing the cylinder liner 3 to the  
14 pumping module 2 is then implemented. This involves  
15 inserting hydraulic fluid into the space 23 between the  
16 head of piston 8 and the baseplate 9, such that the  
17 elastomeric unit 10 is compressed and rods 11 are  
18 extended to a greater extent outwith the top plate 23 of  
19 the housing 7 and the nut 12 is given freedom to be  
20 tightened by further rotation along rod 11 towards the  
21 clamping ring 13 simultaneously. The hydraulic fluid is  
22 then released from the space 23 so that the piston 8  
23 retracts towards the module 2 and the elastomeric member  
24 10 expands. The cylinder 3 is then secured against the  
25 module 2.

26  
27 Preferably, the process of tightening the nuts 12 while  
28 compressing the elastomeric units 10 should be carried  
29 out sequentially around the arrangements 20. It should be  
30 noted that the apparatus and method described herein  
31 allows the nuts 12 to be tightened with light hand tools.  
32 It will be appreciated that this is a considerable  
33 advantage over the requirement of using heavy tools which

1 was, in the past, required.

2

3 The invention thus provides components which are  
4 considerably lighter than comparative components used  
5 heretobefore. In view of negating the requirement of  
6 heavy tooling or handling, the components are less likely  
7 to be damaged during the removal or securing of cylinder  
8 liners and thus the invention permits greater  
9 repeatability and reliability. Furthermore, the need for  
10 intensive manual or skilled by operators is also  
11 mitigated. Similarly, there is a reduced danger of injury  
12 to operators or by-standers during such operational and  
13 maintenance functions.

14

15 It will also be appreciated that, because the apparatus  
16 can be readily dismantled into easily manually  
17 transportable components, installation in difficult  
18 locations can be safely carried out without the need for  
19 heavy lifting equipment. It is a feature of the invention  
20 that, by varying the composition and construction of the  
21 elastomer unit 10, a very wide range of operating duties  
22 can be met allowing accurate matching to each  
23 application. Additionally the use of an elastomer unit  
24 advantageously absorbs shock if the pumping module is  
25 switched on at a high rate.

26

27 Further modifications and improvements may be  
28 incorporated without departing from the spirit or scope  
29 of the invention. For example, though the invention has  
30 particular relevance to reciprocating pumps such as oil-  
31 field mud pumps, the invention is not, however, limited  
32 to mud pumps but finds application in a variety of  
33 reciprocating or positive displacement pumps.

1    Additionally, though the clamping ring in the embodiment  
2    described abuts a lug on the cylinder, cylinders without  
3    lugs may also be used with the invention.

4

1

2 **CLAIMS**

3

4 1. Apparatus for securing a cylinder liner to a pumping  
5 module, the apparatus comprising one or more  
6 arrangements each fastened to said pumping module,  
7 each arrangement comprising an assembly including a  
8 piston, the piston acting on a tension plate, the  
9 tension plate having a stud rod extending therefrom  
10 out from the assembly at an end distal to the  
11 pumping module and thereon passing through a  
12 respective aperture in a clamping member adapted to  
13 grip the cylinder liner, the rod having a first  
14 portion substantially surrounded in an elastomeric  
15 member and a second portion threaded to receive a  
16 nut, wherein initial compression of the elastomeric  
17 member by the tension plate and tightening of the  
18 nut toward the pumping module, followed by release  
19 of the elastomeric member forcibly compel the  
20 cylinder liner towards the pumping module.

21

22 2. Apparatus as claimed in Claim 1 wherein the  
23 elastomeric member comprises a multi-layer structure  
24 having layers of flexible material interleaved with  
25 layers of strengthening material.

26

27 3. Apparatus as claimed in Claim 2 wherein the flexible  
28 material is a rubber.

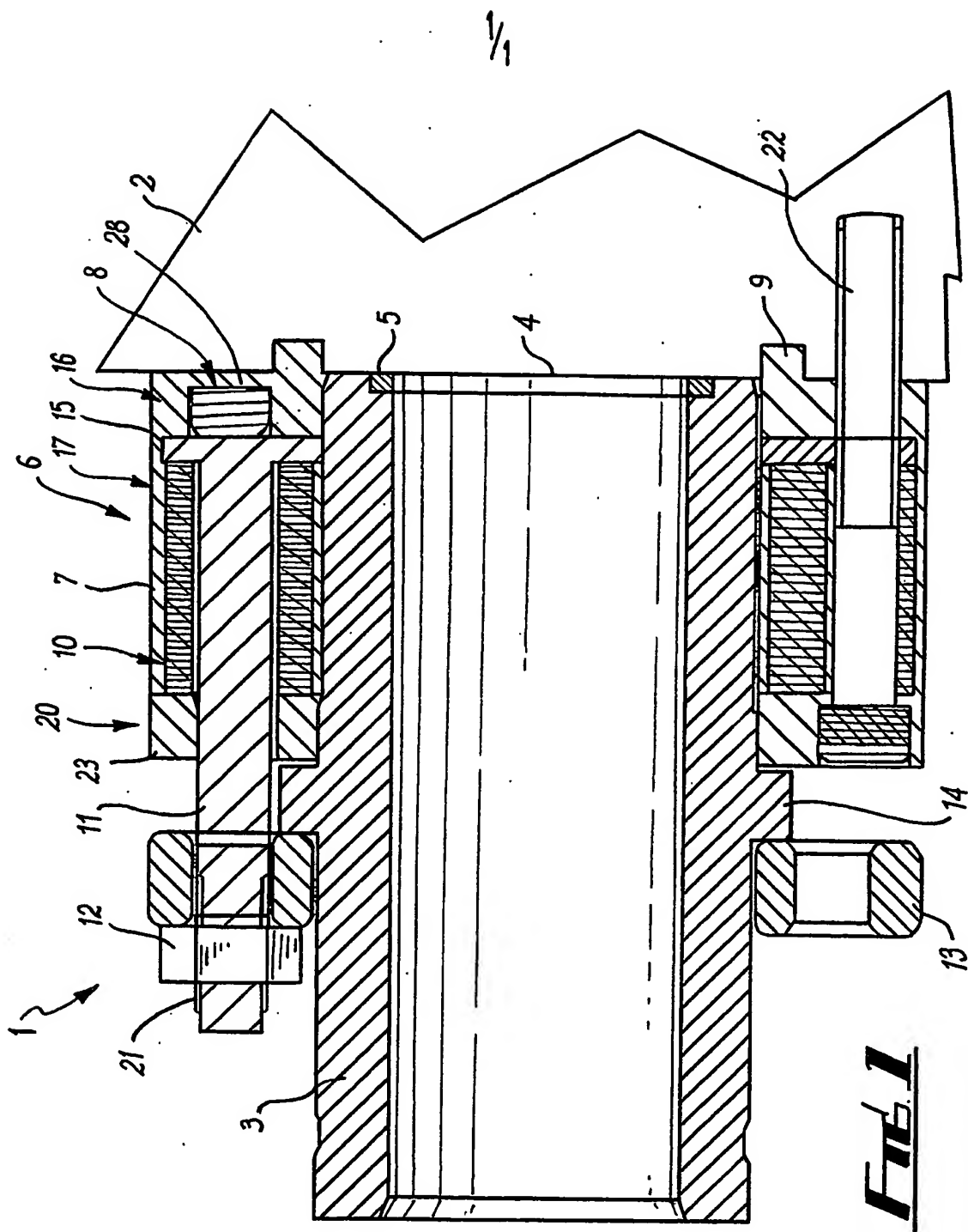
29

30 4. Apparatus as claimed in Claim 2 or Claim 3 wherein  
31 the strengthening material includes a metal.

32

- 1 5. Apparatus as claimed in Claim 2 or Claim 3 wherein  
2 the strengthening material comprises a fabric  
3 reinforcement.  
4
- 5 6. Apparatus as claimed in any preceding Claim wherein  
6 the assembly comprises at least two parts, a first  
7 part including the piston and a second part  
8 including the tensioning plate, rod and elastomeric  
9 member wherein the parts are separable for assembly  
10 and disassembly.  
11
- 12 7. Apparatus as claimed in any preceding Claim wherein  
13 the/each piston is a hydraulic piston.  
14
- 15 8. Apparatus as claimed in Claim 7 wherein the piston  
16 and a base of the first part define a space for  
17 accommodating hydraulic fluid.  
18
- 19 9. Apparatus as claimed in any preceding Claim wherein  
20 there are four arrangements arranged equidistantly  
21 around and externally of a circumference of the  
22 cylinder liner.  
23
- 24 10. Apparatus as claimed in any one of Claims 1 to 8  
25 wherein there are six arrangements arranged  
26 equidistantly around and externally of a  
27 circumference of the cylinder liner.  
28
- 29 11. Apparatus as claimed in any preceding Claim wherein  
30 the clamping member comprises a clamping ring  
31 including the apertures for receiving the stud rods.  
32

- 1 12. A method of securing a cylinder liner to a pumping  
2 module of a pump, the method comprising the steps:  
3 (a) locating a first part of an assembly including  
4 a piston onto the pumping module;  
5 (b) locating a second part of an assembly including  
6 an elastomeric unit and a stud bolt having a  
7 tension plate attached thereto, onto the first  
8 part;  
9 (c) locating the cylinder liner against a seal on  
10 the pumping module;  
11 (d) placing a clamping ring over the cylinder  
12 liner;  
13 (e) inserting the stud bolt through an aperture in  
14 the clamping ring;  
15 (f) placing a nut on a threaded portion of the stud  
16 bolt and locating the nut against the clamping  
17 ring;  
18 (g) actuating the piston against the tension plate  
19 to compress the elastomeric member and force  
20 the stud bolt through the aperture;  
21 (h) at full compression, tightening the nut against  
22 the clamping ring; and  
23 (i) releasing the piston and by the expansion of  
24 the elastomeric member thereby sealing the  
25 cylinder liner to the pumping module.  
26
- 27 13. A method of securing a cylinder liner to a pumping  
28 module of a pump as claimed in Claim 12 including  
29 the step of pumping hydraulic fluid to the piston to  
30 actuate the piston.  
31



## INTERNATIONAL SEARCH REPORT

ational Application No  
r/GB2004/002253

A. CLASSIFICATION OF SUBJECT MATTER  
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According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US R E37 483 E (FLINDALL STEPHEN J ET AL) 25 December 2001 (2001-12-25) cited in the application the whole document	1-13
A	US 6 209 445 B1 (ROBERTS JR EMMETT T ET AL) 3 April 2001 (2001-04-03) column 2, line 49 - column 3, line 11	1,12
A	DE 32 18 000 A (WIRTH CO KG MASCH BOHR) 24 November 1983 (1983-11-24) claim 1; figures 4,5	1,12
A	DE 23 56 604 A (WAGNER MASCHF PAUL HEINZ) 15 May 1975 (1975-05-15) claim 1	1,12
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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# INTERNATIONAL SEARCH REPORT

International Application No  
/GB2004/002253

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 4 550 646 A (MILLER JOHN E)                      5 November 1985 (1985-11-05)                      column 1, line 39 - column 2, line 11                            -----</p>	1,12

# INTERNATIONAL SEARCH REPORT

ational Application No  
/GB2004/002253

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US RE37483	E	25-12-2001	US RE37483 E1 GB 2285489 A ,B US 5572920 A	25-12-2001 12-07-1995 12-11-1996
US 6209445	B1	03-04-2001	AU 6023899 A CA 2342779 A1 GB 2360331 A ,B WO 0014406 A2	27-03-2000 16-03-2000 19-09-2001 16-03-2000
DE 3218000	A	24-11-1983	DE 3218000 A1	24-11-1983
DE 2356604	A	15-05-1975	DE 2356604 A1	15-05-1975
US 4550646	A	05-11-1985	NONE	